MULTI-USER NETWORK SYSTEM AND METHOD OF DATA COMMUNICATION USING ENHANCED PREAMBLE

5 **Background of the Invention**

1. Field of the Invention

This invention relates generally to data communication systems and methods, and more particularly to a system and method for communicating between subscribers over shared media and that provides collision avoidance, robust carrier sense, stable

10 synchronization between stations, and data buffering and decoding in the background.

2. Description of the Prior Art

When using a data communication system based on bursts (packets), the generic format of a frame consists of a preamble at the beginning of each burst. Some

15 communication protocols additionally include data and end-of-frame. The preamble is used to signify (recognize) the start of transmission. All nodes on a network traditionally use the same preamble and the same end-of-frame. Each node, therefore, is required to decode at least the beginning of the data to identify if this message is addressed to itself. Decoding efforts importantly require a real-time computational complexity. Further,

20 traditional data communication processes are made even more complex and time consuming due to the necessity to utilize collision detection and resolve techniques.

In view of the foregoing, a need exists for a scheme to reduce the time associated with collision resolve to increase the effective data communication rate between subscribers using shared media.

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Summary of the Invention

The present invention is directed to a system and method of differentiating individual stations in the PHY layer of a communication network. A technique is used wherein preambles are chosen such that they are easily recognized, even in a very noisy environment in which colliding stations are also considered as noise.

Each station on the net consists of a transmitter and a receiver, which are independent and operate at the same time. The foregoing preamble is used to enhance its traditional functionality discussed herein before, by also identifying the source and destination such that when two or more stations collide, each station will have the ability to immediately recognize the identity of the other stations. When such an event occurs, only one station will continue transmission while the others will stop in a short period of time. The present technique will therefore save the time of collision resolve and thus increase the effective data communication rate of the system.

In one aspect of the invention, a method and associated system are implemented using a unique node preamble to identify the source and the destination node.

In still another aspect of the invention, a method and associated structure are implemented using a unique node preamble to resolve a collision by stopping message transmission "immediately" following source node identification.

In yet another aspect of the invention, a method and associated structure are implemented using a unique node preamble to decode only messages that are addressed to the destination node.

Still another aspect of the invention is associated with a system and method implemented to save entire message samples to a buffer such that message decoding in the background can be achieved using a data processing device such as a CPU or DSP whenever a single node is not required to support the network data rate.

As used herein the following terms have the following meanings. The term "real-time" is used in the context of network data rate. The term "background" is used in the context of station data rate.

Brief Description of the Drawings

Other aspects and features of the present invention and many of the attendant advantages of the present invention will be readily appreciated as the same become better

5   understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts throughout the figures thereof and wherein:

Figure 1 is a radio frame structure according to one embodiment of the present invention; and

10   Figure 2 is a simplified block diagram illustrating transceiver modules suitable for implementing carrier sense and source recognition, destination detection, and collision resolve for the radio frame structure shown in Figure 1.

While the above-identified drawing figures set forth alternative embodiments, other embodiments of the present invention are also contemplated, as noted in the

15   discussion. In all cases, this disclosure presents illustrated embodiments of the present invention by way of representation and not limitation. Numerous other modifications and embodiments can be devised by those skilled in the art which fall within the scope and spirit of the principles of this invention.

Detailed Description of the Preferred Embodiments

Figure 1 is a radio frame structure 100 according to one embodiment of the present invention. The radio frame structure 100 can be seen to have a preamble 102 that

5   not only signifies the beginning of a data packet, but also has a first portion (source preamble) 104 that identifies a particular source and a second portion (destination preamble) 106 that identifies a particular destination. The radio frame structure 100 also has data 108 and an end-of-frame signifier 110. Since the radio frame structure 100 includes both a source preamble 104 and a destination preamble 106, each station can

10   now recognize any other stations within the network. If a collision occurs between any of the stations within the network, only one station will continue transmission while the others will stop in a short period of time. Algorithms, such as discussed herein below, can be used by the individual stations to help them decide which stations should continue transmitting and which stations should stop transmitting. The effective communication

15   data rate of the network will then increase due to a reduced time of collision resolve associated with the enhanced preamble. This reduced time of collision resolve, as stated herein before, is due to reduced decoding efforts since it is no longer necessary to decode any portion of the data 108 to identify if the particular message is addressed to a certain node within the network. Such previous decoding efforts have required complex real-

20   time computations.

The radio frame structure 100 therefore enables differentiating stations in the PHY layer by implementing preamble that are easy to be recognized, even in a very noisy environment where colliding stations are also considered as noise. When a single node (station) is not required to support the network data rate, the entire message can be saved

25   to a buffer for decoding in the station background using its local data processing device, e.g. CPU, DSP and the like. The present invention is not so limited however, and it shall be understood that the source and destination preambles 104, 106 can be implemented in any order or even interleaved, for example.

Figure 2 is a simplified block diagram illustrating transceiver modules 200

30   suitable for implementing carrier sense and source recognition, destination detection, and collision resolve for the radio frame structure 100 shown in Figure 1. The transceiver

modules 200 include a carrier sense and source recognition module 202, a destination detection module 204, and a collision resolve logic module 206. It can be appreciated that a particular implementation of the carrier sense module 202 will determine the overall system performance. Generally, it is beneficial to reach maximum dynamic range

5   in detection of the different preambles 104, 106, such that when two or more stations collide, the power levels might differ by several dB and the network will still be able to recognize the low level stations up to the noise limits.

In view of the foregoing, it can be appreciated that destination detection should be easier to implement since the possibly colliding sources will stop transmission earlier;

10   and only the winning station will remain on the line (plus fading ISI from the colliding stations). Most preferably, each station will detect only its own destination address to assert a buffer write enable to implement storage of burst samples into its associated memory devices.

The collision resolve logic 206 is implemented via algorithmic software, as stated

15   herein before. According to one embodiment, predefined priorities are assigned to each station. When two or more stations collide, the winner will therefore be the one with the highest priority. According to another embodiment, predefined priorities are assigned to each station; but are dynamically changed during operation. During operation, the predefined station priorities between two stations can switch with one another, for

20   example, each time the stations collide. In this way, a more symmetric communication can be implemented. It can be appreciated that the foregoing priority switching scheme can be extended to more than two colliding stations.

In view of the above, it can be seen the present invention presents a significant advancement in the art of communication between subscribers over shared media. An

25   enhanced preamble has been implemented to achieve collision avoidance, robust carrier sense, good synchronization between stations, and data buffering and decoding in the background. Further, this invention has been described in considerable detail in order to provide those skilled in the data communication art with the information needed to apply the novel principles and to construct and use such specialized components as are

30   required. In view of the foregoing descriptions, it should be apparent that the present invention represents a significant departure from the prior art in construction and

operation. However, while particular embodiments of the present invention have been described herein in detail, it is to be understood that various alterations, modifications and substitutions can be made therein without departing in any way from the spirit and scope of the present invention, as defined in the claims which follow. For example,

5   although various embodiments have been presented herein with reference to particular functional architectures and algorithmic characteristics, the present inventive structures and methods are not necessarily limited to such a particular architecture or set of characteristics as used herein. The present invention could just as well be implemented using any scheme that performs well for multiple users on a network based on an

10   enhanced preamble.